A Guide to
Aromatic Gases

BTEX refers to the chemicals benzene, toluene, ethylbenzene and xylene. These compounds occur naturally in crude oil and can be found in sea water in the vicinity of natural gas and petroleum deposits. Other natural sources of BTEX compounds include gas emissions from volcanoes and forest fires.

The primary man-made releases of BTEX compounds are through emissions from motor vehicles and aircrafts, and cigarette smoke. BTEX compounds are created and used during the processing of petroleum products and during the production of consumer goods such as paints and lacquers, thinners, rubber products, adhesives, inks, cosmetics and pharmaceutical products.

BTEX compounds are among the most abundantly produced chemicals in the world. [1]

Volatile Organic Compounds

Many volatile organic compounds (VOCs) are hazardous to human health, with several classified as carcinogenic i.e. capable of causing cancer in humans. One particular group of VOCs, referred to as aromatic hydrocarbons or simply 'aromatics' because of their sweet, pleasant smell are of particular interest because of their widespread use. Aromatics contain at least one aromatic ring of which benzene is the simplest form. Benzene itself forms the basis of the well know group of compounds with the acronym BTEX i.e. Benzene, Toluene, Ethylbenzene and Xylene, shown in figure 1.Ar

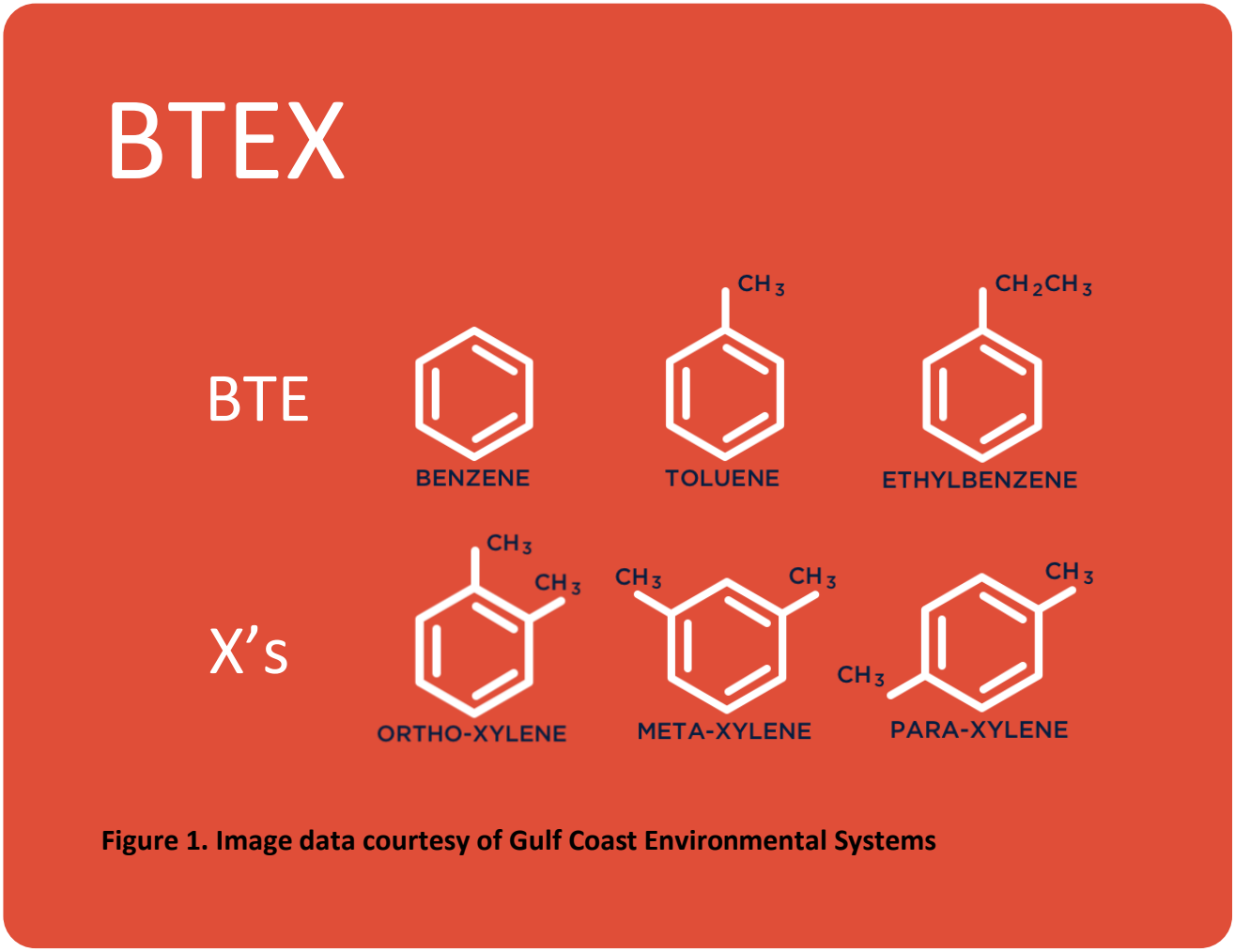


Figure 1. Image data courtesy of Gulf Coast Environmental Systems

Use of BTEX

The importance of aromatics can be seen in the manufacture of many commonly used plastics (figure 2) but they are also used in the manufacture of chemicals, rubber, in solvents, and in paints and lacquers. Each will be covered in more detail.

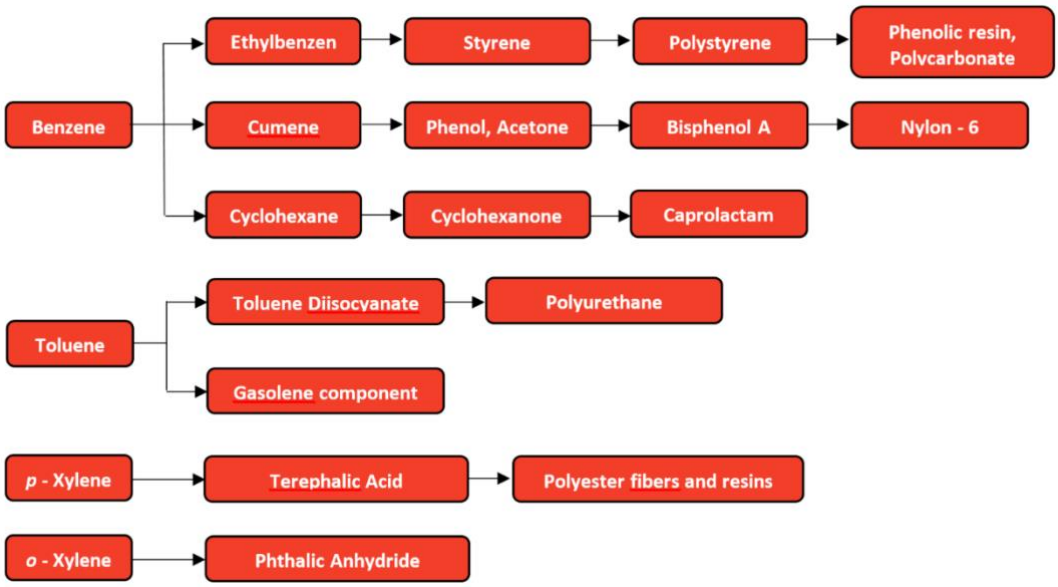


Figure 2: The chain of petrochemicals derived from the BTEX aromatics (source Wikipedia)

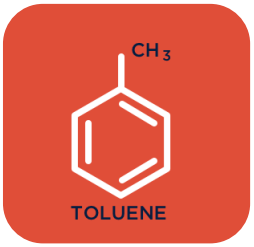
Benzene

Benzene (C_6H_6) is a clear, colourless and highly flammable liquid with a sweet petrol-like smell. Most people can just detect its distinctive smell at concentrations between 2.5 and 5 parts per million (ppm) in air. Benzene occurs naturally in crude oil and is also found in ambient air as a result of burning fuels, such as coal, petrol and wood and is common in unleaded fuel, where it is added as a substitute for lead, allowing smoother running.

Benzene's primary uses are in the fabrication of other chemicals including ethylbenzene, cumene, cyclohexane, nitrobenzene and alkyl benzene with ethylbenzene being the most common. Benzene can also be found in phenol, acetones for resins and adhesives, nylon, rubbers, lubricants, dyes, detergents, drugs, explosives and pesticides.

Toluene

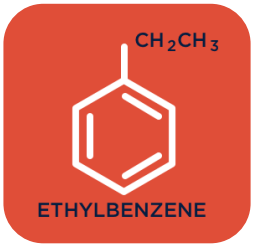
Toluene (C7H6), also known as methylbenzene, is a colourless liquid, with a strong, solvent-like smell. Widely used as an industrial feedstock as well as a solvent, toluene is a highly flammable chemical. Toluene is found naturally at low levels in crude oil and is a by-product of the production of petrol (gasoline) as well as the production of coke from coal. Purification is done during a final separation by any distillation or solvent extraction process used for BTEX aromatics.



Toluene is used in the manufacturing of polyurethane foam, trinitrotoluene aka TNT explosive and a number of synthetic drugs is feedstock for toluene diisocyanate and a precursor to other chemicals. Also used as a solvent for paints, paint thinners, silicone sealants, rubber, printing ink, adhesives, glues, lacquers, leather tanners and disinfectants. As a fuel, toluene is used as an octane booster in petrol (gasoline) for internal combustion engines, as a fuel for two-stroke and four-stroke engines, jet fuel surrogate blends. Alternative applications range from breaking red blood cells open in order to extract haemoglobin in biochemistry experiments and as a cement in polystyrene kits as it can be applied with precision by brush without the bulk of adhesives, to name a few.

Ethylbenzene

Ethylbenzene (C6H5CH2CH3), is a colourless liquid, with a petrol-like aroma. Ethylbenzene is widely used in industrial processes for the manufacture of styrene, one of the most common plastics, which is then used for polystyrene manufacture. Although 99% of ethylbenzene is used in the production of plastics there are other uses for the monocyclic aromatic hydrocarbon, including fuel, solvent in ink, rubber adhesive, varnish and paints. Other uses includes as an ant-knock agent in patrol (gasoline) to reduce engine knocking and increase the octane rating.



Xylene

Xylene (C_8H_{10}) is the term used to describe the three isomers of dimethyl benzene; m-xylene, p-xylene and o-xylene. Usually concentrations of each are added together as total xylenes. Xylene is refined from crude oil, and is a clear, greasy liquid.

Xylene is the main precursor to terephthalic acid and dimethyl terephthalate both of which are monomers used in the production of polyethylene terephthalate plastic bottles and polyester clothing. About 98% of the production of Xylene is for these two products with other applications including as a solvent in the printing, rubber and leather industries. Often a component of ink, rubber, adhesives, paint thinners, varnishes, as a cleaning agent and even as a root canal treatment in dentistry or the active ingredient in products used for the cleaning of ear wax, the uses for Xylene are wide reaching. Historically Xylene was used as a precursor chemical compound for tear gas used in World War I.

Why monitor?

Like all VOCs, they have a high vapour pressure which means they evaporate (volatilise) at ambient temperature and pressure, which means that they can easily enter the body through normal breathing. As well as inhalation, they can be absorbed into the body through the skin or by swallowing material containing it.

The effects on worker's health depends upon how much they are exposed to *and* for how long and, as with other organic solvents, the immediate effects of a single exposure to a high concentration (hundreds of ppm) e.g. from a fugitive process leak, include headache, tiredness, nausea, dizziness and even unconsciousness if the exposure is very high (thousands of ppm) meaning an acute safety incident. Long term, lower level exposure can lead to chronic disease such as cancer.

Workers might be exposed due to fugitive emissions during normal plant operations or during turnaround, for example, in:-

- Oil refineries
- Chemical and petrochemical plants
- Coke works
- Foundries
- The storage, distribution and use of petrol

The health effects of BTEX and how to monitor them are discussed in subsequent guides.

Disclaimer

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Reference:

1. https://www.ehp.qld.gov.au/management/non-mining/btex-chemicals.html

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